REMARKS

By the present amendment and response, independent claim 1 and dependent claims 2-3 and 5-10 have been amended to overcome the Examiner's objections. Claims 23 and 24 have been canceled. Thus, claims 1-10, 21-22, and 25-30 remain pending in the present application. Reconsideration and allowance of pending claims 1-10, 21-22, and 25-30 in view of the following remarks are requested.

The Examiner has rejected claims 1-10 under 35 USC §112, second paragraph. Applicant has amended claims 1, 3, and 5-10 in response to the Examiner's objection and submits that the requirements of 35 USC §112, second paragraph, have been met.

The Examiner has further rejected claim 23 under 35 USC §112, second paragraph. Applicant has canceled claim 23.

The Examiner has further rejected claims 1-10, 21, 22, 24-28, and 30 under 35 USC §103(a) as being unpatentable over U.S. patent application publication number 2002/0127847 to Alling et al. ("Alling") in combination with U.S. patent number 6,398,926 B1 to Lotar Peter Mahneke ("Mahneke"), U.S. patent number 3,706,635 to Xavier Kowalski ("Kowalski"), and U.S. patent number 6,486,533 B2 to Krishnamoorthy et al. ("Krishnamoorthy"). For the reasons discussed below, Applicant respectfully submits that the present invention, as defined by amended independent claim 1, is patentably distinguishable over Alling, Mahneke, Kowalski, and Krishnamoorthy, singly or in any combination thereof.

The present invention, as defined by amended independent claim 1, teaches, among other things, electroplating a copper (Cu) surface in a chemical solution, "wherein the chemical solution comprises at least one wetting agent for stabilizing the chemical solution, wherein the at least one wetting agent is provided in a concentration less than 0.1 g/L," thereby forming a copper-zinc (Cu-Zn) alloy film on the Cu surface," and "wherein the Cu-Zn alloy film has a zinc (Zn) content in a concentration less than 1.0 atomic % such that the Zn content of the Cu-Zn alloy film causes a minimal increase in a resistance of the Cu-Zn alloy film." As disclosed in the present application, the present invention's Cu-Zn electroplating solution facilitates improved filling of a Cu-Zn alloy film on an interconnect, especially for feature sizes in a dimensional range of approximately 0.2 μm to approximately 0.05 μm, thereby lowering the resistance of the formed Cu-Zn alloy film. The present invention's Cu-Zn electroplating solution also provides a desirably low Zn content, e.g. in a concentration less 1.0 atomic %, in a Cu alloy interconnect, which advantageously imparts a minimal increase in resistance as well as a substantial improvement in electromigration resistance of formed Cu-Zn alloy film.

Furthermore, the Cu-Zn alloy film is electroplated on a Cu surface using a stable chemical solution in prescribed concentration ranges. For example, the chemical solution can comprise at least one wetting agent, where the at least one wetting agent is provided in a concentration less than 0.1 g/L. As a result, the present invention advantageously achieves improved Cu interconnect reliability, improved corrosion resistance, and reduced manufacturing costs.

In contrast to the present invention as defined by amended independent claim 1, Alling does not teach, disclose, or suggest electroplating a copper (Cu) surface in a chemical solution, "wherein the chemical solution comprises at least one wetting agent for stabilizing the chemical solution, wherein the at least one wetting agent is provided in a concentration less than 0.1 g/L," thereby forming a copper-zinc (Cu-Zn) alloy film on the Cu surface," and "wherein the Cu-Zn alloy film has a zinc (Zn) content in a concentration less than 1.0 atomic % such that the Zn content of the Cu-Zn alloy film causes a minimal increase in a resistance of the Cu-Zn alloy film." Alling specifically discloses electroplating a second metal layer, e.g. zinc and copper alloy, over a first metal layer, e.g. copper, where the second metal layer is substantially less conductive than the first metal layer. See, for example, Alling, page 2, paragraph [0022] and page 3 paragraphs [0028] and [0029]. In Alling, the preferred resistivity of the second metal layer is at least about 20 to 400 or 500 percent greater than the resistivity of the first electrically conductive (metal) layer, e.g. copper layer. See, for example, Alling, page 3, paragraph [0028]. Thus, in contrast to the present invention as discussed above, Alling is not directed to electroplating a second metal layer, e.g. zinc and copper alloy, over a first metal layer, e.g. copper, where the second metal layer has a resistivity than is minimally greater than the resistivity of the first metal layer.

Furthermore, Alling fails to teach, disclose, or suggest electroplating a copper-zinc (Cu-Zn) alloy film on a Cu surface, where the Cu-Zn alloy film has a zinc (Zn) content in a concentration less than 1.0 atomic % such that the Zn content of the Cu-Zn alloy film

causes a minimal increase in a resistance of the Cu-Zn alloy film." In fact, Alling fails to teach, disclose, or suggest any particular concentration of Zn in a Cu-Zn alloy film or adjusting the concentration of Zn such that the Cu-Zn alloy film has a minimal increase in resistance.

In contrast to the present invention as defined by amended independent claim 1, Mahneke does not teach, disclose, or suggest electroplating a copper (Cu) surface in a chemical solution, "wherein the chemical solution comprises at least one wetting agent for stabilizing the chemical solution, wherein the at least one wetting agent is provided in a concentration less than 0.1 g/L," thereby forming a copper-zinc (Cu-Zn) alloy film on the Cu surface," and "wherein the Cu-Zn alloy film has a zinc (Zn) content in a concentration less than 1.0 atomic % such that the Zn content of the Cu-Zn alloy film causes a minimal increase in a resistance of the Cu-Zn alloy film." The Examiner relies on Mahneke for providing motivation to enable the formation of the copper-zinc alloy film of Alling to be performed and obtain further advantage of preventing contamination on both surfaces of the wafer. Mahneke specifically discloses an electroplating chamber having a rotatable chuck, i.e. chuck 44, which allows plating, rinsing, and drying steps of an electroplating process to be performed in the same chamber. See, for example, Mahneke, column 2, lines 28-38 and column 5, lines 6-7. However, Mahneke fails to teach, disclose, or suggest, chemical solution for electroplating a Cu-Zn alloy film on a Cu surface, where the chemical solution comprises at least one wetting agent for stabilizing the chemical solution, and where the at least one wetting agent is provided in a

concentration less than 0.1 g/L. Further, Mahneke fails to teach, disclose, or suggest a Cu-Zn alloy film having a Zn content in a concentration less than 1.0 atomic % such that the Zn content of the Cu-Zn alloy film causes a minimal increase in a resistance of the Cu-Zn alloy film. Thus, Mahneke fails to overcome the deficiencies of Alling discussed above.

In contrast to the present invention as defined by amended independent claim 1, Kowalski does not teach, disclose, or suggest electroplating a copper (Cu) surface in a chemical solution, "wherein the chemical solution comprises at least one wetting agent for stabilizing the chemical solution, wherein the at least one wetting agent is provided in a concentration less than 0.1 g/L," thereby forming a copper-zinc (Cu-Zn) alloy film on the Cu surface," and "wherein the Cu-Zn alloy film has a zinc (Zn) content in a concentration less than 1.0 atomic % such that the Zn content of the Cu-Zn alloy film causes a minimal increase in a resistance of the Cu-Zn alloy film." The Examiner relies on Kowalski to provide the motivation to enable the step of admixing the chemical solution with a volume of water in the combination process to be performed. However, Kowalski fails to teach, disclose, or suggest a chemical solution for electroplating a Cu-Zn alloy film on a Cu surface, where the chemical solution comprises at least one wetting agent for stabilizing the chemical solution, and where the at least one wetting agent is provided in a concentration less than 0.1 g/L. Further, Kowalski fails to teach, disclose, or suggest a Cu-Zn alloy film having a Zn content in a concentration less than 1.0 atomic % such that the Zn content of the Cu-Zn alloy film causes a minimal increase in a

resistance of the Cu-Zn alloy film. Thus, Kowalski fails to overcome the deficiencies of Alling discussed above.

In contrast to the present invention as defined by amended independent claim 1, Krishnamoorthy does not teach, disclose, or suggest electroplating a copper (Cu) surface in a chemical solution, "wherein the chemical solution comprises at least one wetting agent for stabilizing the chemical solution, wherein the at least one wetting agent is provided in a concentration less than 0.1 g/L," thereby forming a copper-zinc (Cu-Zn) alloy film on the Cu surface," and "wherein the Cu-Zn alloy film has a zinc (Zn) content in a concentration less than 1.0 atomic % such that the Zn content of the Cu-Zn alloy film causes a minimal increase in a resistance of the Cu-Zn alloy film." The Examiner relies on Krishnamoorthy to provide the motivation to enable the formation of the chemical solution of the combination process to be performed and obtain further advantage of solving the diffusion and self-passivation problems in metallization structure. Krishnamoorthy specifically discloses copper-zinc alloy layer 40 having a more preferable zinc content below about 2 atomic percent. See, for example, Krishnamoorthy, column 5, lines 27-28. Krishnamoorthy states that the zinc content should be chosen to balance the resistivity of the layer against the oxidation resistance and copper-confinement properties. See, for example, Krishnamoorthy, column 5, lines 38-40. However, Krishnamoorthy fails to teach, disclose, or suggest a Cu-Zn alloy film having a Zn content in a concentration less than 1.0 atomic % such that the Zn content of the Cu-Zn alloy film causes a minimal increase in a resistance of the Cu-Zn alloy film.

For the foregoing reasons, Applicant respectfully submits that the present invention, as defined by amended independent claim 1, is not suggested, disclosed, or taught by Alling, Mahneke, Kowalski, and Krishnamoorthy, either singly or in combination thereof. As such, the present invention, as defined by amended independent claim 1, is patentably distinguishable over Alling, Mahneke, Kowalski, and Krishnamoorthy. Thus claims 2-10, 21, 22, 25-28, and 30 depending from amended independent claim 1 are, *a fortiori*, also patentably distinguishable over Alling, Mahneke, Kowalski, and Krishnamoorthy for at least the reasons presented above and also for additional limitations contained in each dependent claim.

The Examiner has further rejected claim 23 under 35 USC §103(a) as being unpatentable over Alling in combination with Mahneke, Kowalski, and Krishnamoorthy, and further in view of U.S. patent number 6,309,524 B1 to Woodruff et al. Applicant has canceled claim 23.

The Examiner has further rejected claim 29 under 35 USC §103(a) as being unpatentable over Alling in combination with Mahneke, Kowalski, and Krishnamoorthy, and further in view of U.S. patent number 3,919,056 to Edward Paul Habulak. As discussed above, amended independent claim 1 is patentably distinguishable over Alling in combination with Mahneke, Kowalski, and Krishnamoorthy and, as such, claim 29 depending from amended independent claim 1 are, *a fortiori*, also patentably distinguishable over Alling in combination with Mahneke, Kowalski, and

Krishnamoorthy for at least the reasons presented above and also for additional limitations contained in dependent claim 29.

Based on the foregoing reasons, the present invention, as defined by amended independent claim 1 and claims depending therefrom, is patentably distinguishable over the art cited by the Examiner. Thus, claims 1-10, 21-22, and 25-30 pending in the present application are patentably distinguishable over the art cited by the Examiner. As such, and for all the foregoing reasons, an early allowance of claims 1-10, 21-22, and 25-30 pending in the present application is respectfully requested.

Respectfully Submitted,
FARJAMI & FARJAMI LLP

Date: 1/15/04

Michael Farjami, Esq.
Reg. No. 38, 135

Michael Farjami, Esq.
FARJAMI & FARJAMI LLP
16148 Sand Canyon
Irvine, California 92618
Telephone: (949) 784-4600
Facsimile: (949) 784-4601

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed: Mail Stop RCE, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

Date of Deposit: 1/15/04

Sukkie Bal
Name of Person Mailing Paper and/or Fee

1/15/04
Signature Date